

REMARKS

Claims 1-15 are pending in this application. Of these claims, claims 1-10 have been examined and claims 11-15 have been withdrawn due to a restriction requirement.

Claims 1, 3-6 and 9-10 stand rejected under 35 U.S.C. §102(b) or, in the alternative, under 35 U.S.C. §103(a) as being unpatentable over JP09-221539. Claims 2 and 7-8 stand rejected under 35 U.S.C. §103(a) as being unpatentable over JP09-221539 in view of the article to Engle et al. (A Review of Thermally Controlled Covalent Bond Formation in Polymer Chemistry).

Applicants respectfully traverse these rejections.

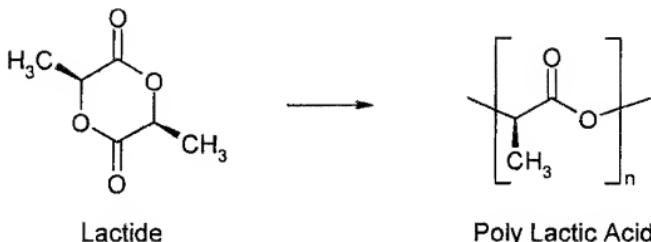
Among the limitations of independent claim 1 which are neither disclosed nor suggested in the prior art of record is a shape-memory resin having “a glass transition temperature (Tg) within the range of 40°C to 200°C and crosslinked by a thermoreversible reaction in which a covalent bond is formed by cooling and dissociated by heating”, and wherein “a dissociation temperature (Td) of the thermoreversible reaction is 50°C to 300°C” and satisfies the relationship: $Tg + 10^\circ\text{C} \leq Td$.

Applicants respectfully submit that JP09-221539, either alone or combined with Engle et al., does not teach or suggest the present invention as defined in independent claim 1.

The Office Action alleges that “the composition disclosed by the reference is prepared from reactants and under process conditions that are inclusive in the claimed reactants and conditions. In view of this similarity, it would appear that the Tg, Td and the equation must be considered inherent in the prior art.” Applicants respectfully disagree.

JP09-221539 discloses a biodegradable thermoplastic resin as a shape memory resin, particularly, polylactic acid type resin. This thermoplastic resin does not include a crosslinking structure by a covalent bond. In particular, the lactic acid type resin of JP09-221539 is composed of a linear polymer of polylactic acid, which produces a shape memory property by the tanglement of polymer chains, particularly a lactic acid type resin having an average molecular weight of at least 100,000 (See paragraph [0012] of the enclosed mechanical English translation of the JP09-221539

reference from the JP Patent Office). Therefore, the lactic acid type resin of the JP09-221539 reference does not have a dissociation temperature (T_d) of the thermoreversible reaction defined in the independent claim 1. In the synthetic example described in the JP09-221539 reference, 100 parts by weight of L lactide, 0.05 parts by weight of lauryl alcohol and 0.2 parts by weight of octylic acid tin were reacted to prepare poly L lactic acid. This reaction is shown below:



In the reaction described in the JP09-221539 reference, the octylic acid tin is a ring-opening polymerization catalyst, and the lauryl alcohol appears to be used as a plasticizer to decrease a glass transition temperature. As can be seen from the above reaction, the composition disclosed by the JP09-221539 reference does not have a thermoreversible crosslinking structure. There is no teaching or suggestion in the JP09-221539 reference that such a thermoreversible crosslinking structure is introduced in the resin.

In contrast, the shape memory resin defined in independent claim 1 is a resin which has a thermoreversible crosslinking structure covalently crosslinked at a temperature of not less than the T_g of the resin and dissociated at a temperature of a shaping temperature. The shape-memory resin defined in independent claim 1 has excellent shape recovery power since it operates as a thermosetting resin in shape-memorizing and shaping-recovery operations, and is also excellent in

shaping and reshaping properties since it operates as a thermoplastic resin in shaping and reshaping operations.

The differences between the resin of JP09-221539 and the invention defined in independent claim 1 are set forth in the present application. Specifically, in the Example section of the present application, a commercially available polylactic acid was used as a base polymer, and the base polymer was modified by trans-esterification and then reacted with a crosslinker such as a trifunctional maleimide [R3] to introduce a thermoreversible crosslinking structure. See paragraphs [0119]-[0124] of the present application. Comparative example 1 disclosed in the present application at paragraph [0143] uses the commercially available polylactic acid and corresponds to the resin obtained from the JP09-221539 reference. As demonstrated in Table 1 of the present specification at paragraph [0145], the commercially available polylactic acid did not show the claimed T_d and was inferior in shape memory properties and reshape properties compared with the shape memory resin defined in independent claim 1. Accordingly, it is respectfully submitted that independent claim 1 patentably distinguishes over the JP09-221539 reference.

Engle et al. does not remedy any of the deficiencies of JP09-221539. Engle et al. does not disclose or suggest a shape-memory resin having “a glass transition temperature (T_g) within the range of 40°C to 200°C and crosslinked by a thermoreversible reaction in which a covalent bond is formed by cooling and dissociated by heating”, and wherein “a dissociation temperature (T_d) of the thermoreversible reaction is 50°C to 300°C” and satisfies the relationship: T_g + 10°C ≤ T_d. Therefore, even if one were to combine the teachings of JP09-221539 and Engle et al., one would not arrive at the present invention as defined in independent claim 1.

Accordingly, it is respectfully submitted that independent claim 1 patentably distinguishes over the art of record.

Claims 2-15 depend either directly or indirectly from independent claim 1 and include all of the limitations found therein. Each of these dependent claims include additional limitations

which, in combination with the limitations of the claims from which they depend, are neither disclosed nor suggested in the art of record. Accordingly, claims 2-15 are likewise patentable.

In view of the foregoing, favorable consideration and allowance of the present application with claims 1-10 is respectfully and earnestly solicited.

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